INDOOR AIR QUALITY ASSESSMENT

First District Court of Barnstable
Route 6A
Barnstable, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
November 2003

Background/Introduction

At the request of Christopher McQuade, Administrative Office of the Trial Court, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the First District Court of Barnstable (FDCB), Route 6A, Barnstable, Massachusetts. The assessment was prompted by complaints from employees related to mold contamination and other indoor air quality issues.

On August 28 and 29, 2003, Michael Feeney, Director of the Emergency Response/Indoor Air Quality (ER/IAQ) Program visited the FDCB. The FDCB is a two-story, split level structure built into the side of a hill. The building consists of two wings, north (Picture 1a) and south (Picture 1b), which are connected by a main lobby. The upper floor of the north wing contains the 1st session court, judges' chambers and the clerk's office. The lower floor of the north wing contains the juvenile probation office, juvenile court and boiler room. The upper floor of the south wing contains the adult probation office and 2nd and 3rd session courts. The lower floor of the south wing, which is partially below grade, contains the victim assistance program, the delegate's room, the jury room and the law library. Rooms on both upper levels are equipped with openable windows. With the exception of the juvenile session court and several offices, most areas on the ground level do not have windows.

BEHA staff have evaluated the FDCB on two separate occasions prior to the current assessment. An initial assessment was conducted on October 1, 1998 at the request of the Barnstable County Health Department (MDPH, 1998). The 1998 assessment is included as Appendix A of this report. In response to reports of extensive mold colonization in the law library book collection, the BEHA made a subsequent visit on September 20, 2000

(MDPH, 2000). The 2000 assessment is included as Appendix B of this report. Recommendations to improve indoor air quality were made in each of the previous assessments.

In addition to ventilation concerns, the current assessment report focuses on conditions contributing to mold growth. Findings pertaining to water damage and mold colonization were detailed in a previous letter (MDPH, 2003), which is included as Appendix C. More recent mold colonization resulted from unprecedented, extended humid weather conditions experienced in Massachusetts' communities in August and September 2003.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-Trak ™, IAQ Monitor Model 8551. The tests were taken under normal operating conditions.

Results

The FDCB has a population of approximately 70 employees. The tests were taken under normal operating conditions and results appear in Table 1. Air samples are listed in Table 1 by location.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million parts of air (ppm) in all areas surveyed. These carbon dioxide levels are indicative of an adequate fresh air supply in the building. Several different types of ventilation systems supply air to the building. Upper levels in both wings, as well as the lobby and some lower level offices have fresh air provided by unit ventilators (univents) (Figure 1, Picture 2). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an air intake located at the base of each unit. Fresh and return air are mixed and filtered, then heated or cooled before it is provided to rooms through an air diffuser located in the top of the unit. In order for univents to provide fresh air as designed, air diffusers and return vents must remain free of obstructions. However, the univent in the 2nd session courtroom is located behind the judge's bench. In this configuration, air is drawn from underneath the judge's bench into the univent. It is probably worthwhile to note that during the 1998 BEHA assessment, several fresh air intakes were noted to be partially enclosed with sheet metal. Blocking of univent air intakes limits airflow. Barnstable County officials reported that these univent fresh air intakes were blocked to prevent freezing of pipes. At the time of this assessment, most of the air intakes were no longer sealed.

With the exception of some lower level offices, mechanical ventilation for lower level areas is provided by air handling units (AHUs). Fresh air is drawn through air intakes located in a subterranean pit (Picture 3). Ductwork connected air intakes and ceiling mounted fresh air diffusers facilitate distribution of fresh air. Air is returned to the AHU

through large grates that are located in the library, the victim protection office (Picture 4a) and the main reception area for the juvenile probation office (Picture 4b).

In the original design, it appears that return vents for the juvenile probation and victim protection offices were placed in large open areas or hallways. These open areas were later subdivided into offices through the installation of gypsum wallboard (GW) and suspended ceilings. The subdivision of these offices required a system modification that allows return air to be drawn from office areas and into hallways. To facilitate airflow, office doors are typically undercut approximately one-inch to provide a space through which air can be drawn into the hallways. At the FDCB, office doors did not appear to be undercut, thus limiting the amount of air transfer from offices to the hallway when office doors are closed. Furthermore, restrooms and break rooms have fresh air supplies connected to lower level air handling units. This configuration is unusual for restrooms, since odors and water vapor could be forced into occupied areas if the restrooms become pressurized.

As with supply, different types of ventilation systems exhaust air from the building. Intake vents that are connected to rooftop motors via ductwork provide exhaust ventilation in upper and lower level courtrooms, as well as upper level offices. Exhaust ventilation in upper and lower level restrooms and break rooms are also provided by this rooftop unit (Blueprints 1 and 2). Upper level offices appeared to have minimal exhaust ventilation. No exhaust vents were observed in the clerk's, parole, or probation offices on the upper floor. Insufficient exhaust ventilation can allow normally occurring environmental pollutants to build up and lead to air quality/comfort complaints.

The ventilation system for the lower level does not appear to be designed for mechanical exhaust ventilation. The blueprints indicate that fabric barometric dampers were installed to allow for the diffusion of air from ground floor areas (Blueprint 3, Picture 5). The function and problems associated with these dampers are described in detail in Appendix B. With the exception of restroom exhaust vents, the juvenile probation offices did not have barometric fabric dampers or a means for exhaust ventilation.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a univent and exhaust system, these systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this occurs a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration

(OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please consult Appendix D.

Temperatures were measured in a range of 69^{o} F to 73^{o} F, which were very close to the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range between 70^{o} F to 78^{o} F in order to provide comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measurements in this building ranged from 47 to 65 percent, which were slightly above the BEHA comfort range in several areas. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As previously noted, the building visit was prompted by concerns regarding water damage and subsequent mold growth on building materials. Findings and BEHA recommendations pertaining to water damage and mold growth are detailed in a letter previously released (Appendix C). The following list details conditions that may contribute to moisture penetration into the FDCB that have resulted in condensation generation and/or mold colonization.

- Fabric barometric dampers: The installation of fabric barometric dampers can allow unconditioned air to enter the building. For example, the operation of the AHU in the victim assistance office likely draws substantial moisture in to the area through the fabric barometric vent. Moisture can then be distributed to upper level areas by the ventilation system. Please note that as a result of previous BEHA recommendations, a mechanical exhaust fan was installed in the barometric vent within the library. The installation of this fan has prevented water penetration into the library. Library staff did not report any additional problems with mold colonization on the book collection, even during the hot, humid weather of August 2003.
- Univent ductwork: The univent ductwork for the fresh air intake openings in the side of the building is undersized. This condition allows unconditioned outdoor air to penetrate into the ceiling plenum of the lower level.
- Window system: Outdoor light could be seen from the ceiling tile system above the juvenile session courtroom, in a section *without ductwork* (Picture 6). This indicates that breaches may exist in the window systems of the building. These breaches allow moist air to enter into the ceiling plenum.

- Exhaust ventilation: As previously noted, general exhaust ventilation does not appear to exist in the offices of this building. The lack of exhaust ventilation results in the accumulation of water vapor inside the building.
- Univent drip pans: Several univents in the upper level clerk's office were examined. While drip pans were cleaned, significant amounts of debris had accumulated in the drip pans and the condensation collectors (Picture 7). Furthermore, drip pan insulation in examined units was not replaced or repaired, as previously recommended (Picture 8). Without intact insulation, condensation can accumulate on metal univent components and cause the univent cabinet and surrounding carpet to become wet.

Of significant concern is the deactivation of the chiller component of the ventilation system. Barnstable County officials report that noise produced from the operation of the chiller is subject of a civil lawsuit from an abutting neighbor (Weir, N. v. O'Leary, R.A.; LeClair, M.J. and Dolen, C. 1997). The chillers of the building HVAC system are located near the resident's property line (Blueprint 4), adjacent to a residential driveway that borders the FDCB. To accommodate the neighbor, Barnstable County officials have agreed to deactivate the ventilation system during specified hours. From Monday through Friday, the ventilation system is deactivated at 4:00 PM and restarted the next morning at 6:00 AM. During the weekend, the ventilation system is deactivated at 4:00 PM on Friday and reactivated Monday at 6:00 AM. Deactivation of the ventilation system has produced a number of moisture problems within the FDCB. During the first weeks of August 2003 when extreme hot and humid weather persisted, the air conditioning system should have been operating to prevent condensation generation in the building. Condensation is the collection of moisture on a surface that has a temperature below the dew point. The dew

point is a temperature that is determined by air temperature and relative humidity. For example, at a temperature of 80^{o} F and relative humidity of 80%, the dew point for water to collect on a surface is approximately 76^{o} F. If cold, conditioned air from the HVAC system chills the interior of the building below 76^{o} F, building materials at or below this temperature would be expected to generate condensation.

Lack of exhaust ventilation, deactivation of the air conditioning system and uncontrolled penetration of hot, humid air during August 2003 most likely produced conditions that caused water damage and provided an opportunity for mold growth to occur.

Plants that are located on windowsills and tables in several offices may also offer the potential for mold growth. Excessive watering and breaches in plant holders have resulted in water damage to wood and carpeting. Water damage to wood and carpeting can, in turn, spur mold growth. Plant soil and drip pans can also be a source of mold growth. Plants should be located away from univents and exhaust ventilation. Trees and shrubbery can also be a source of mold and pollen. Some trees and/or shrubbery located along the building exterior were blocking fresh air intakes of univents. This condition can result in entrainment and distribution of mold and pollen to the FDCB.

Other Concerns

Barnstable County officials and Mr. McQuade provided BEHA staff with the contract (DCAM, 2003) and blueprints (Shekar & Associates, Inc., 2003) detailing proposed renovations to the building's HVAC system. These plans include replacement of univents throughout the building. If this renovation project proceeds, measures to repair the building envelope (window systems), install univent fresh air intake ducts in a proper

manner and provide adequate mechanical exhaust ventilation for offices on both the upper and lower levels should be considered. Without addressing these issues, the current project is likely to produce similar condensation generation problems that have been experienced in this building for a number of years.

Conclusions/Recommendations

As noted in previous BEHA assessments, the design of the FDCB contributes to its ongoing problems with condensation generation. The remediation/replacement of water damaged/mold contaminated materials (e.g. carpeting, ceiling tiles, GW, paneling and pipe insulation) will remove the point source of respiratory irritants. *However, the removal of these materials without addressing sources causing condensation generation will likely result in future molds problems within the during hot, humid weather.* Unconditioned air and water vapor entrainment through the building envelope must be prevented to eliminate mold colonization of building components. This step does not address the lack of mechanical exhaust ventilation for office areas; however it would decrease the overall water vapor load for the building. Employee symptoms and complaints reported during this assessment are consistent with those experienced in an environment with microbial growth and a poorly operating ventilation system. To address concerns, a two phase approach is required, including short-term recommendations to improve air quality and long term measures requiring planning and resources to adequately address overall indoor air quality concerns.

Short Term Recommendations

1) Implement corrective actions recommended by BEHA in a letter addressing removal of mold contaminated materials (Appendix C).
2) Carefully evaluate overall renovation project plans. If project moves forward, measures to repair the building envelope (window systems), install univent fresh air intake ducts in a proper manner and provide adequate mechanical exhaust ventilation for offices on both the upper and lower levels should be considered.
3) Provide a three-foot space between shrubbery and fresh air intakes to prevent entrainment of pollen and microbial contaminants. Remove this vegetation after-hours to prevent entrainment of pollutants into fresh air intakes.
4) Consider installing passive air vents in the base of the judge's bench to enhance air circulation in the 2nd session courtroom.
5) Examine the feasibility of constructing an enclosure around the air conditioning chiller to prevent noise transmission into the abutting neighbor's property.
6) Operate the air conditioning system continually during hot, humid weather, once the chiller enclosure is installed.

Long Term Recommendations

1) Repair the building's window frame system by sealing breaches and spaces.
2) Install univent fresh air intakes in manner that prevents penetration of outdoor air into the ground floor ceiling plenum.
3) Examine the feasibility of installing mechanical exhaust ventilation in office areas on the upper and lower building levels.
4) Install return vents in the ceiling plenum for lower level offices.
5) Consider removing carpeting from lower level offices.

References

BOCA. 1993. The BOCA National Mechanical Code-1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL.

DCAM. 2003. Contract for Massachusetts State Project Number TRC0009 Contract No. HC1 HVAC System Improvements Barnstable District Court, Barnstable, Massachusetts. Division of Capital Assets management, Boston, MA.

MDPH. 1998. Indoor Air Quality Assessment for Barnstable District Court, Barnstable Massachusetts. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA.

MDPH. 2000. Letter to The Honorable Barbara Dortch-Okara, Chief Justice for Administration and Management from Suzanne Condon, Assistant Commissioner, Bureau of Environmental Health Assessment regarding water damage concerns at the Barnstable District Court, dated October 20, 2000. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA.

MDPH. 2003. Letter to The Honorable Barbara Dortch-Okara, Chief Justice for Administration and Management from Suzanne Condon, Assistant Commissioner, Bureau of Environmental Health Assessment regarding water damage concerns at the Barnstable District Court, dated September 19, 2003. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA.

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SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

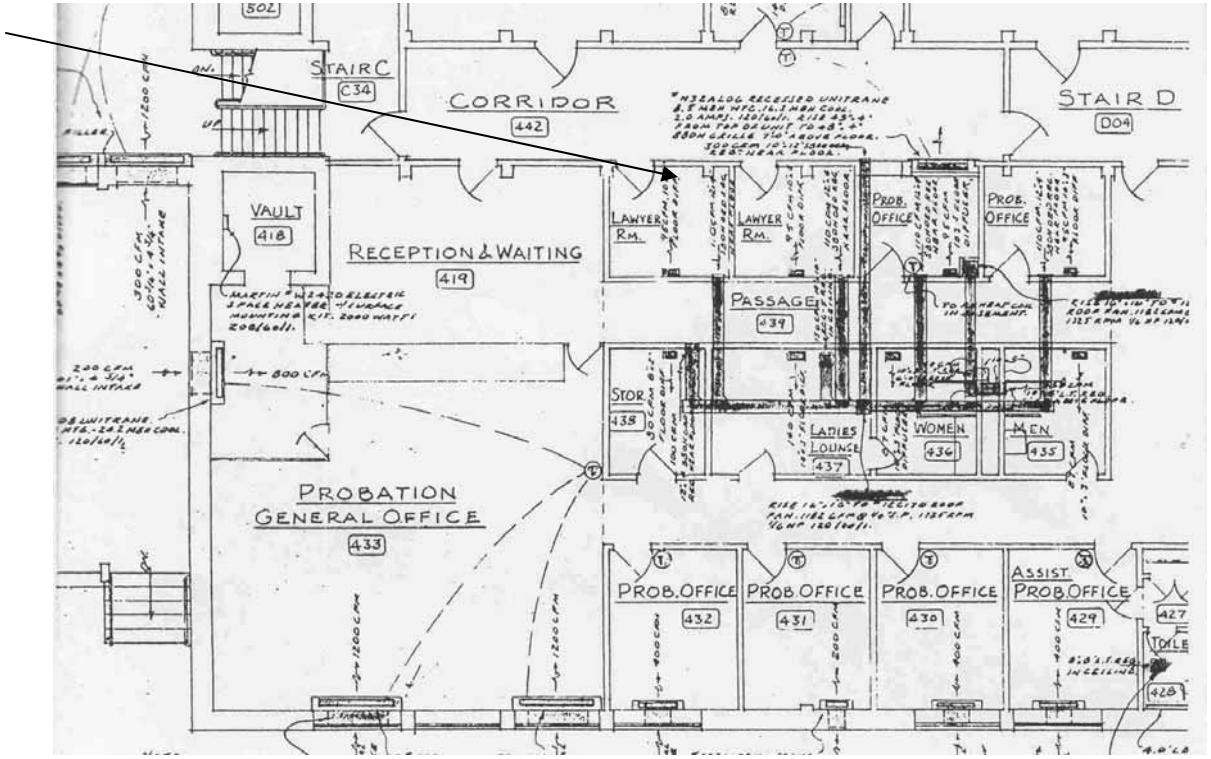
Weir, N. v. O'Leary, R.A.; LeClair, M.J. and Dolen, C. 1997. Complaint. Commonwealth of Massachusetts, Barnstable, ss. Superior Court Civil Action Number 97-56. Filed January 17, 1997.

WMGA. 1969a. Utility Plan, Courthouse for the First District of the County of Barnstable, Barnstable, Massachusetts. Walter M. Gaffney Architects, Address unknown.

WMGA. 1969b. Floor Plan of First and Second Levels, Courthouse for the First District of the County of Barnstable, Barnstable, Massachusetts. Walter M. Gaffney Architects, Address unknown.

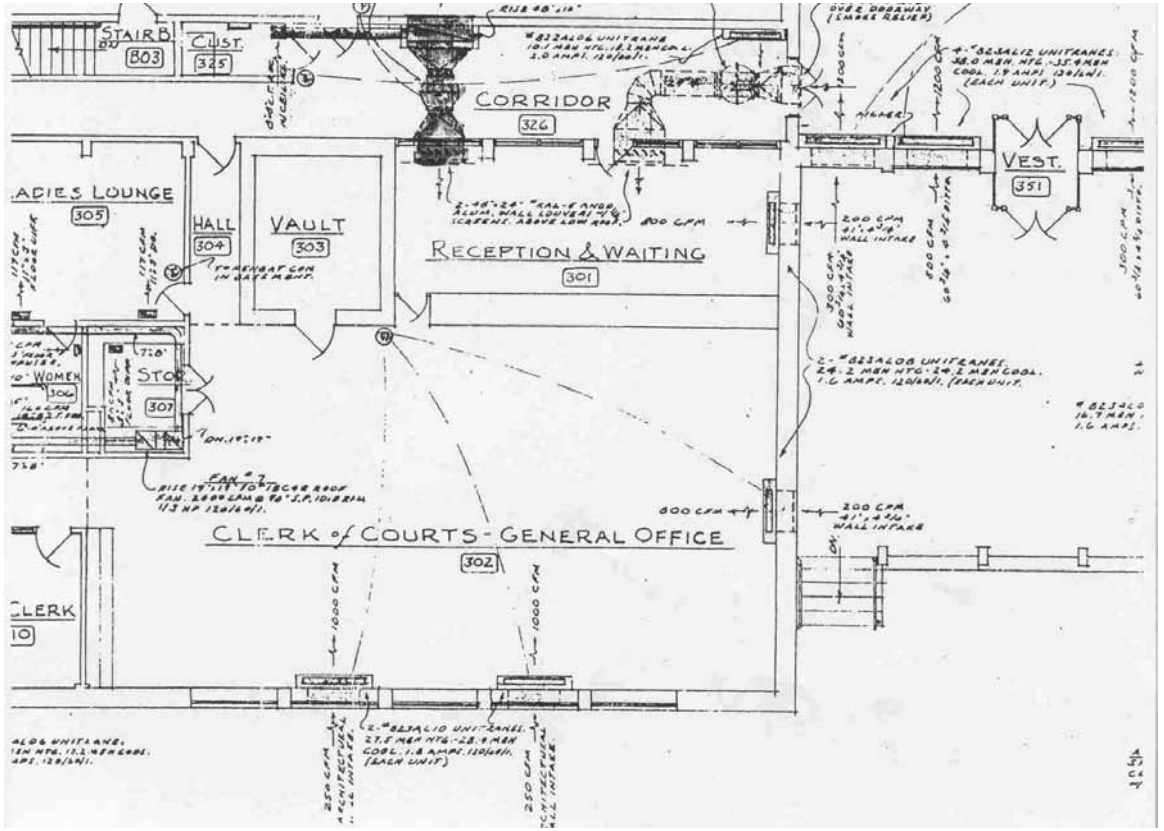
WMGA. 1969c. Floor Plan of Third and Fourth Levels, Courthouse for the First District of the County of Barnstable, Barnstable, Massachusetts. Walter M. Gaffney Architects, Address unknown.

Blueprint 1



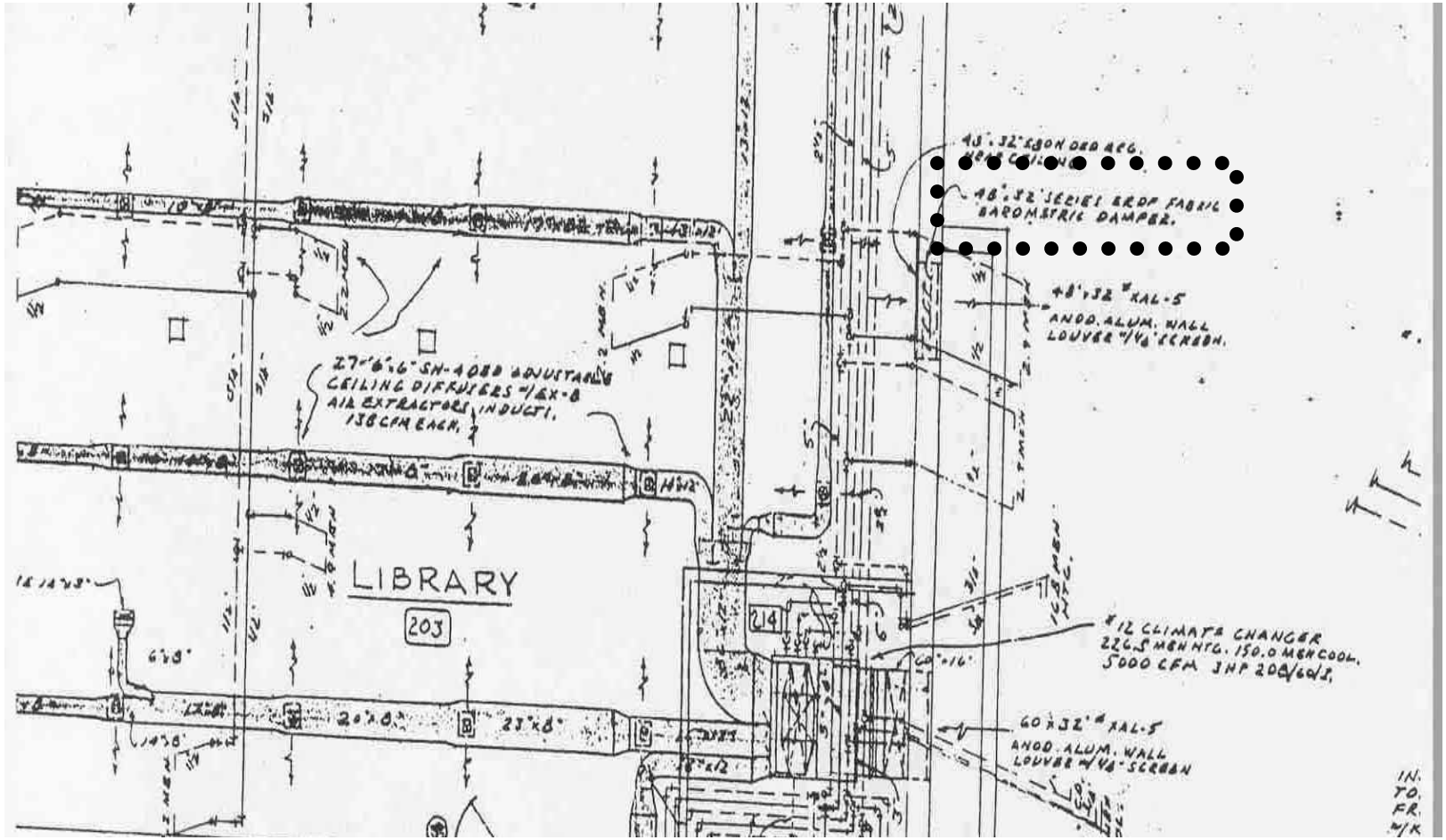
HVAC Configuration of Upper Level Probation Office
Note No Vents Depicting Exhaust Vents Except Ladies Lounge

Blueprint 2



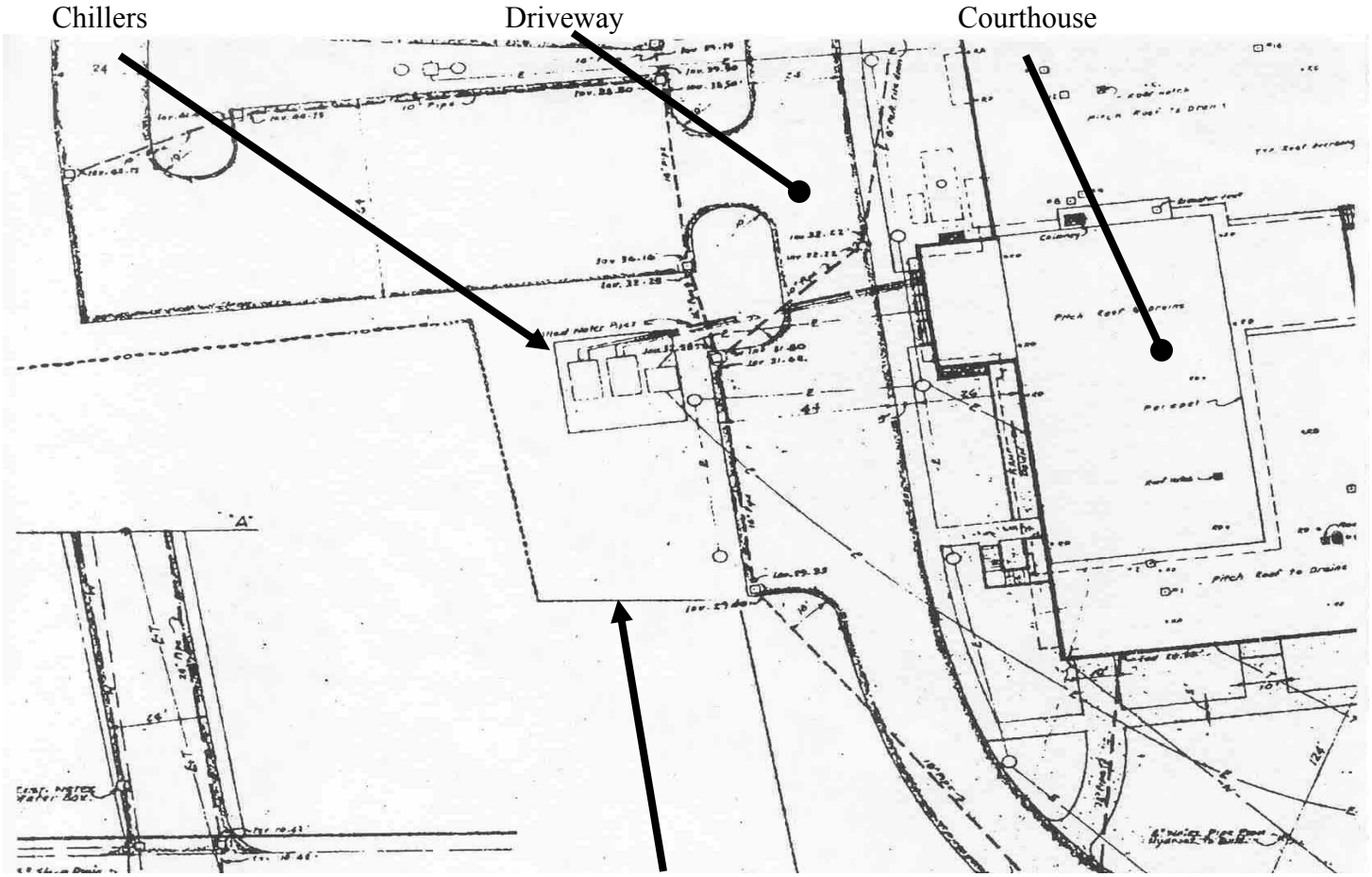
HVAC Configuration of Upper Level Clerk of Courts Office
Note No Vents Depicting Exhaust Vents Except Ladies Lounge and Restrooms

Blueprint 3



Fabric Barometric Damper Used for Exhaust Ventilation in Library

Blueprint 4



HVAC System Chillers Located Near The Resident's Property Line

Picture 1a

North Wing of Building

Picture 1b

South Wing Built Into the Hill

Picture 2

Univents

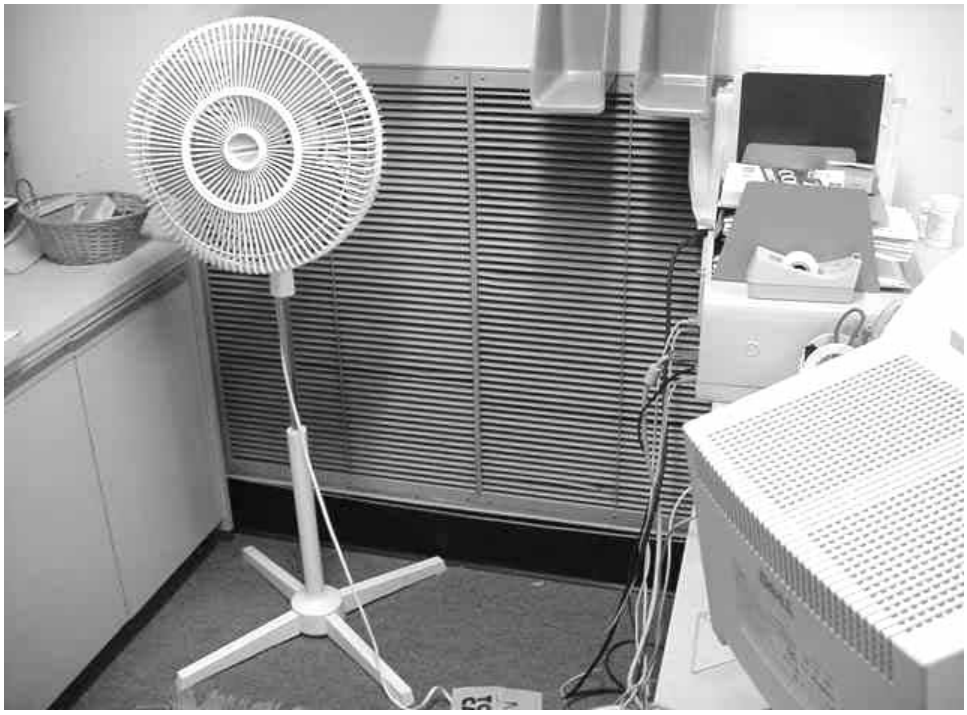
Picture 3

AHUs Draw Fresh Air through A Subterranean Pit

Picture 4a

Return Air Vent for Victim Assistance Office (View Inside Mechanical Room)

Picture 4b



Return Air Vent for Juvenile Probation Offices Located in the Main Reception Area for the Juvenile Probation Office

Picture 5

Fabric Barometric Dampers in the Victim Assistance Office

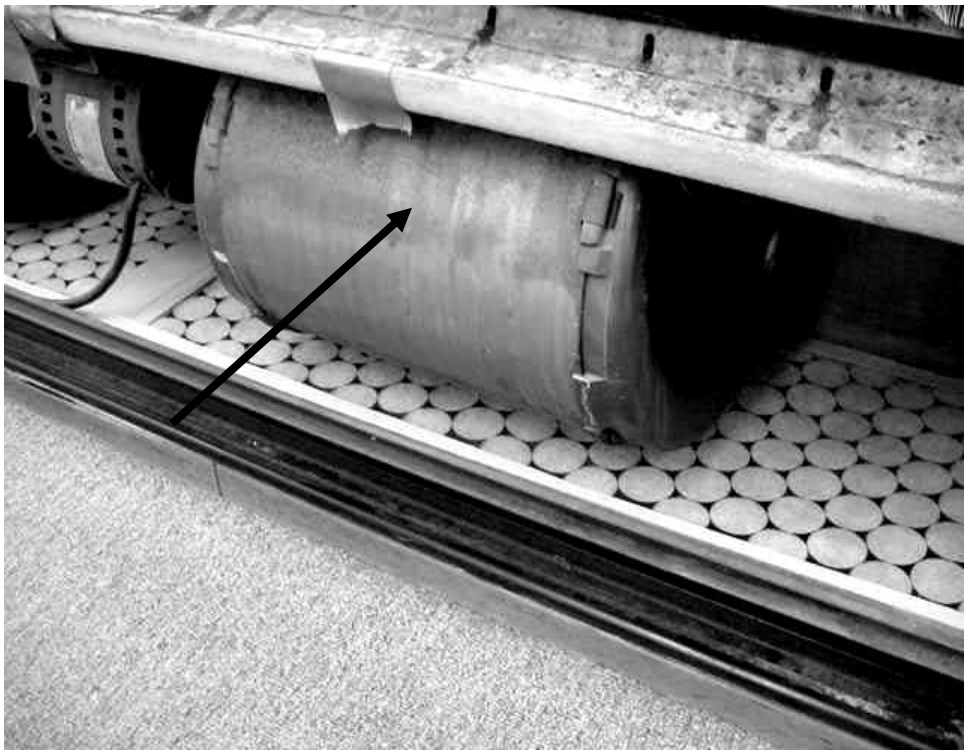
Picture 6

Light Visible through Spaces in the Window System, (Note Water Stains Indicating Moisture Penetration)

Picture 7

Debris Accumulation in the Condensation Drain Collector

Picture 8



Damaged Insulation of Univent Drip Pans (**Note Corrosion** on **Fan Casing** below **Drip** Pan, Which **Is Likely From Condensation Exposure**)

TABLE 1

Indoor Air Test Results – Barnstable First District Court – Barnstable, MA August 29, 2003

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Juvenile Session	476	69	56	0	Y	Y	Y	Pipe insulation; 10+ WD-CT; WD carpet and wall paneling; bowed CT
Room 340	554	72	53	1	Y	Y off	N	WD Carpet; DO
Room 322	480	75	51	0	N	Y	N	
Room 323	497	74	53	1	N	Y	Y	Plants; 2 WD CT; DO; WD carpet and windowsill
Room 324	499	73	54	0	N	Y	N	5 WD-CT; DO
Room 319	499	73	54	0	N	Y	N	
Room 320	454	72	58	2	N	Y	Y	Open Window
Juv. Court Clerks Office	463	73	57	1	N	Y	N	DO
Telephone Operators	456	72	60	1	N	Y	Y	DO; 3 WD-CT

ppm = parts per million parts of air
GW = gypsum wallboard
WD = water damage

DO = door open
OW = open window
CT – ceiling tile(s)

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 1

Indoor Air Test Results – Barnstable First District Court – Barnstable, MA August 29, 2003

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Court Clinic	495	72	65	1	N	Y	Y	
Room 317	489	71	56	0	Y	Y	Y off	Plants
Clerk Magistrate	656	71	54	10	Y	Y off	N	WD carpet – GW
Lounge	601	72	57	1	N	Y	Y	WD carpet; DO
Room 310	517	72	55	0	N	y	N	Plants; DO
Room 311	482	71	52	0	Y	Y	Ex. RR off	Plants; DO
Room 312	445	72	50	0	Y	Y	N	WD windowsill with Plant; DO
Room 314	473	71	52	0	Y	Y	N	Plants
1st Session	728	70	57	29	N	Y	Y	Heavy WD Panel; OW

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Main Lobby	647	70	58	24	N	Y	Y	Musty Odor; Plants
2nd Session court room	415	67	59	0	N	Y	Y	WD Panel; Dehumidifier
2nd Session Judges Chambers	448	68	63	0	N	Y	Y	Plant
3rd Session CR								
3rd Session Waiting Room	602	71	52	10	N	Y	Y	WD panel; Dehumidifier
Adult Probation	833	72	56	5	N	Y		
Room 432	718	71	57	0	N	Y	N	DO
Lounge	709	71	59	0	N	Y floor	Y	
Room 431	632	71	59	0	N	Y	Y Low	DO

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Room 411	615	71	59	0	N	Y	N Lo	DO
Room 429	600	71	59	0	N	Y	N Lo	Plants; DO
Room 426	639	71	58	0	N	Y	Y RR	Plants blocking HVAC; DO
Room 424	665	72	60	1	N	Y	N Lo	DO; HVAC blocked
Room 423	661	72	58	0	N	Y		DO
Room 409	822	72	58	0	N	Y	Y	DO
Room 403	617	72	58	0	N	Y	Y	Chair blocking; HVAC
Room 396		77	58		N	Y	Y	DO; File cabinet blocking HVAC
Room 229	501	70	58	2	N	Y	Y	Desk blocking HVAC; DO; Open grille and doors

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						Supply	Exhaust	
Library	478	72	55	5	N	Y	Y	
Head Admin. Assistant	507	72	57	1	N	Y	D vent off	Plant; DO
Judge's Secretary	501	72	57	1	N	Y	D vent off	Plant; DO
Judges Chambers	671	74	47	2	Y	Y		Carpet Musty; Plants Dehumidifier
Judges Lobby	623	73	48	0	Y	Y	Y off	
Room 302 Clerks Magistrate	875	72	50	14	Y	Y	N	WD; GW; Odor; Plants
Room 310	699	72	50	0	Y	Y	N	Plants

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